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EXPERIMENTAL ENTOMOLOGY.

Experimentelle Entomologische Studien vom physikalisch-chemischen Standpunkt aus. By Prof. P. Bachmetjew. Zweiter Band; mit 25 Tafeln. Pp. xvi+944+cviii. (Sophia: Staatsdruckerei, 1907.)

ALTHOUGH it is well known that many excellent observers have of late years devoted their attention to experimental work of which insects are the subject, it is probable that few students of entomology have realised hitherto how large is the mass of material that has now been accumulated in this department of research. The present work is somewhat of a revelation. Its tale of nearly a thousand pages consists almost entirely of a condensed account of the investigations conducted by various experimenters on the influence of external factors on the phenomena of insect life. Even so, the list is not quite complete, for, though the author, working under many difficulties, has displayed an amount of industry in collecting his material that is really astonishing, we could yet name more than one memoir bearing on the subject that seems to have escaped his vigilance. We note, for example, the omission of any reference to the striking experiments of Mr. G. A. K. Marshall on South African Lepidoptera. Nevertheless, the compilation has, on the whole, been admirably executed, and Prof. Bachmetjew's bulky volume will be indispensable to those workers in the subject who wish to have the results of nearly all previous investigations in a readily accessible form. The amount of labour saved to his colleagues in entomology by the author's determination to record every relevant fact hitherto ascertained by experiment is quite incalculable.

The work is divided into two parts, the first dealing with the actual results obtained by various investigators, the second giving the theoretical conclusions considered by these and other authorities to be warranted by the experiments in question. As might be expected, these speculative opinions are of very unequal value, and it is to be observed that the author makes little or no attempt to decide between them when they are contradictory, or to condemn them when erroneous. He has rather set before himself the task of recording without distinction, not only every fact relating to his subject, but also every conclusion at any time suggested, whether the latter be good or bad. His own views, save on a few points, are not much in evidence. It is clear from this that the book has serious limitations; these, however, do not prevent it from being extremely useful within the scope allowed it by its author. The insects dealt with naturally belong almost entirely to the order of Lepidoptera.

The effects of the various external factors are considered in their relation to the time occupied in development, to the size and form of the perfect insect, and to its ultimate colouring and pattern. Under each of these main heads the influence is considered of climate, moisture, temperature, light, the colouring of the surroundings, food, including

chemical food-material artificially employed, electricity, magnetism, friction, artificial constriction, pressure, gravitation, and other factors.

The author defers to a future treatise the questions of seasonal dimorphism, protective resemblance, mimicry, and parthenogenesis. The omission of these subjects, especially of the first three, marks a further limitation of an important character, for they often have a special bearing on the interpretation of such facts as are here recorded. Indeed, inasmuch as an appreciation of the significance of the changes induced by the operation of external factors is often entirely dependent on a knowledge of the insect in question in its relation to seasonal, mimetic, and cryptic conditions, the present treatise, useful as it is, can only be considered as a partial introduction to the theory of the subject.

The book is fitly dedicated to Dr. Max Standfuss, of Zürich, whose experiments, conducted on a very large scale, have, perhaps, done more than those of any other investigator to establish our knowledge of the effects of temperature applied during the immature stages on the form and colouring of the perfect insect. His experiments in hybridisation, although carried out before attention had been generally directed to the epoch-making work of Mendel, are also very worthy of note. Next to Standfuss's experiments, perhaps the most important work of this nature is that conducted through many years by Mr. F. Merrifield at Brighton, and we are glad to see that due prominence is given to his admirable investigations in Prof. Bachmetjew's pages. Among other work carried out by English experimenters is that of Prof. Poulton, which also comes in for appreciative notice, but here we cannot fail to observe the somewhat unfortunate effect of the author's determination to reserve the question of protective coloration for future treatment. Much of the significance of Poulton's results on the effect of surrounding objects on the colouring of larvæ and pupæ is thus for present purposes lost. It is from their bearing on evolutionary problems that data of this kind derive their highest interest, and we must once more remark on the opportunities thus missed by the author. We may hope, however, that the omission is only of a temporary character, and that we shall yet see a treatise from his hand which will throw fresh light on many questions of primary importance in the study of evolution.

The plates consist for the most part of graphic representations of the statistical results furnished by the tables in the body of the work. They are useful as exhibiting series of facts in a form which by most people is more easily appreciated than a bare numerical statement.

It will have been gathered from the foregoing remarks that Prof. Bachmetjew's volume is mainly designed as a work of reference. In accordance with this plan, the literature of the subject has been very carefully catalogued, and the bibliography, which occupies seventy-seven pages at the end of the book, besides occasional lists given in the text, is of a very full description. It is true that there are omissions, but these do not appear to be numerous.

The author is already favourably known for his excellent *résumé* of observations and experiments relating to temperature in insects, this, with the present volume, constituting the first two instalments of his projected "Experimental Studies in Entomology." The production of the third volume of the series will be awaited with interest.

F. A. D.

INFINITE SERIES.

An Introduction to the Theory of Infinite Series. By T. J. I'A. Bromwich. Pp. xvi+511. (London: Macmillan and Co., Ltd., 1908.) Price 15s. net.

THE first impression this book is likely to produce is that, considering its title, it is very big. However, it is not diffuseness that is to blame for this; the fact is that quite a third of the volume consists of matter that does not strictly come under the title, but is either introductory or supplemental. Thus we have an appendix dealing with irrational numbers and limits; another on logarithms and exponentials; a third on infinite integrals and gamma functions.

It is pleasant to find the author adopting Dedekind's definition of an irrational number, the only one which is really scientific. In the second appendix, the exponential function is introduced after the logarithm, but as the latter is defined by an integral, this does not matter much. There can be little doubt that for methodical treatment, the integral definition of $\log z$, with the elements of the theory of complex integration, is by far the most satisfactory; and it does not introduce any gratuitous difficulties. The third appendix is interesting, because it introduces recent results obtained by the author, Mr. Hardy, and others, which illustrate very clearly how the problems of series are complicated when we pass to integrals over an infinite range. In passing, it may be observed that Mr. Bromwich refers with due appreciation to Mr. Gibson's excellent text-book on the calculus.

Passing on to the main subject of the book, it is curious to note how much there is that is comparatively recent. Of course, Abel and Cauchy were the great pioneers; but if we take, for instance, the distinction between uniform and non-uniform convergence, this does not seem to have been fully recognised before Stokes's paper of 1847 (see Mr. Bromwich's note, p. 115); and the new definitions of the "sum" of a divergent series are creations of yesterday.

The subject last mentioned is discussed in chapter xi., mainly after Borel and Cesàro, and is a good example of the extension of mathematical terms. Borel gives a process by which, from a divergent series (or sequence) Σ , we can in certain cases find an expression $S(\Sigma)$ which is finite. Moreover, if Σ is a convergent series, $S(\Sigma)$ is the sum in the ordinary sense, and if $S(\Sigma)$, $S(\Sigma')$ exist, then $S(\Sigma + \Sigma') = S(\Sigma) + S(\Sigma')$. Mr. Bromwich makes some very interesting comparisons between this recent theory and some of Euler's transformations of divergent or oscillating series. Like Fourier, Euler had a wonderful instinct, which led him right, even when his logic was defective.

It is fairly plain that, with the exception of convergent series, there is no one definition of the sum superior to all others; different definitions may be useful for different purposes. Again, with regard to ordinary series, there is no universal test for convergence, except, of course, the definition; and the same remark applies to integrals with infinite limits. Oddly enough, one of the most useful tests for the convergence of a series (p. 35) is practically due to Gauss.

One of Mr. Bromwich's great merits is that he constructs examples to show the fallacy of various plausible assumptions which have occasionally misled even the elect. For instance (p. 99), we have a product $\Pi(1+u_n)$ which is convergent, although Σu_n and Σu_n^2 both diverge. The discussion of double series is also very instructive. The fact is that any actual case of summation is the construction of a linear sequence $s_1, s_2, s_3, \&c.$; so-called derangements or permutations of series are best regarded as constructions of new series, the terms of which have a one-one correspondence to those of the first. Two series thus related may, or may not, have the same sum.

Attention should be directed to the discussion (pp. 157-60) of certain Fourier series, especially as to the limiting form of the curve

$$y = \sin x + \frac{1}{2} \sin 2x + \dots + n^{-1} \sin nx,$$

when n increases indefinitely. Reference might have been made to the correspondence in NATURE, vol. lix. (1898), in which Willard Gibbs and Prof. Michelson took part. The point is that the limiting form is not a mere zig-zag but a zigzag with projecting spines.

Finally, a word may be said about the examples, which are very numerous and diversified. It is perhaps a trifling matter in itself, but to some minds it will give satisfaction, that as modern analysis is becoming assimilated, illustrations of it are being produced which have something of the elegance and individual beauty of the Cambridge or Oxford problem of years gone by. After all, a plant must grow before it flowers.

G. B. M.

STUDIES IN EDUCATION.

The Demonstration Schools Record. Being Contributions to the Study of Education by the Department of Education in the University of Manchester. No. 1. Edited by Prof. J. J. Findlay. Pp. xvi+126. (Manchester: The University Press, 1908.) Price 1s. 6d. net.

THE work before us is to be regarded rather as an introduction to future issues of the "Record" than as an arranged and classified record of the results of educational observation and experiment. Here the authors take us into their confidence; we are told what their view of a demonstration school is, what questions they hope to solve, and on what principles they think the answers should be sought. When the future volumes are available the record will be one in which full confidence can be placed; it will not be a statement of partial facts selected consciously or unconsciously to fit a particular theory. For this